Technical Manual for
Mini Pulser
Model MP-1

eberline

eberline service centers

July 1, 1980

Certified Calibration and Repair

Eberline Instrument Certified Calibration	Call Service Center for prices.
Other Manufacturer Instrument Certified Calibration	$100.00 each
Repair Rate Above Calibration plus Parts at List Price	$60.00/hr.

Contractual rates are available on periodic repair and/or calibration. Contact Service Center for prices.

Three (3) Year Extended Warranty:

This includes Certified Calibration plus Parts

1. Eberline Instruments, FOB Eberline Customer Service Facility . . . $70.00 each/quarter

Miscellaneous:

1. Turn Around Time:

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   Repair — Twelve (12) working days on Eberline instruments, unless parts have to be ordered.

2. FOB Santa Fe, New Mexico or West Columbia, South Carolina

3. Instruments for warranty repair, repair, or calibration must be sent to:

   Mr. Henry Gomez
   Customer Service
   Eberline Instrument Corporation
   P.O. Box 2108, Airport Road
   Santa Fe, New Mexico 87501
   Telephone: 505/471-3232

   Mr. John Witzell
   Customer Service
   Eberline Instrument Corporation
   312 Miami Street
   West Columbia, South Carolina 29169
   Telephone: 803/796-3604

4. In addition, the following Customer Service Centers are available for customers outside the United States.

   Eberline Instrument Co., Ltd.
   Church Street
   Dorking Surrey
   England, RH41DQ
   Telephone: 44-306-87836

   Saskatchewan Research Council
   Attn.: Mr. Don Barnett
   30 Campus Drive
   Saskatoon, Saskatchewan
   Canada, S7N 0X1
   Telephone: 306/664-5433

Prices at these locations will vary from U.S. prices. Please contact the facilities for current price and delivery information.

EBERLINE INSTRUMENTS STANDARD WARRANTY

One Year Warranty: Seller warrants to replace or repair, at its option, any products or parts thereof (excluding tubes, crystals and batteries [tubes and crystals 90 days]) which are found defective in material or workmanship within one year from date of shipment. Seller's obligation with regard to such products or parts shall be limited to replacement or repair, FOB seller's factory or authorized repair station, at seller's option. The aforesaid warranty does not cover normal life-end failure of components and will be voided if repair has been attempted by other than seller's authorized personnel. In no event shall seller be liable for consequential or special damages, transportation, installation, adjustment, work done by customer or other expenses which may arise in connection with such defective product or parts.

Exclusion of Warranties and Limitation of Liability: **The foregoing warranty is expressly made in lieu of any and all other warranties express or implied including the warranties of merchantability and fitness for a particular purpose. Under no circumstances shall seller be liable for any indirect, special, incidental or consequential damages to customer or to any third party.**

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7	Change 5	April 19, 1976

Pages 2 through 7 have been repaginated.

TABLE OF CONTENTS

Section | Page

I GENERAL

Purpose and Description 1
Specifications 1

II OPERATION

Description of Controls and Connectors 2
Using the Instrument 2
III THEORY OF OPERATION 3

IV MAINTENANCE

Disassembly 4
Preventative Maintenance 4
Calibration 4
Troubleshooting 4
V PARTS LIST 5
VI DIAGRAMS 7

LIST OF ILLUSTRATIONS

Figure | Page

1-1 Mini Pulser, Model MP-1 ii
6-1 General Schematic, Mini Pulser, Model MP-1 7

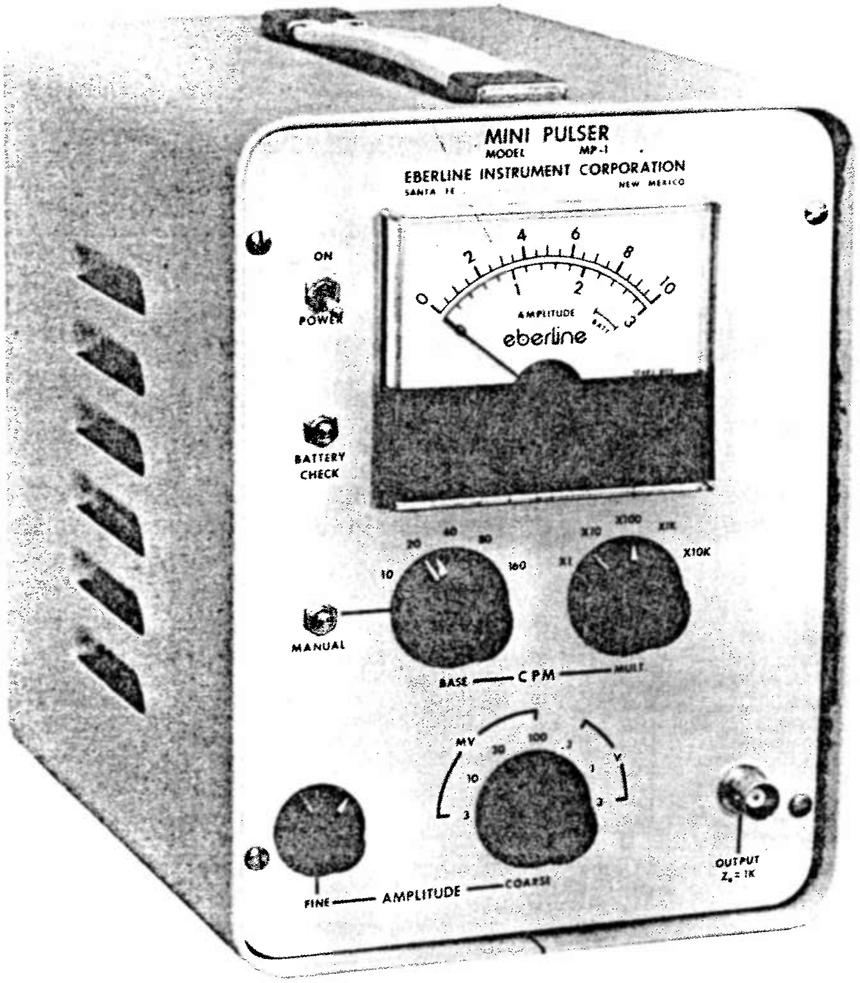


Figure 1-1. Mini Pulser, Model MP-1

SECTION I
GENERAL

A. PURPOSE AND DESCRIPTION

The Model MP-1 Mini Pulser is a small, lightweight pulse generator specifically designed to aid in calibrating or troubleshooting pulse counting instruments. The pulse repetition rate is variable from 10 cpm (counts per minute) to 1.6 million cpm in discrete steps of 2 and is accurate to better than 0.1%. The pulse shape is tailored to simulate most radiation detectors so the counting electronics will operate properly. The pulse amplitude is continuously variable from less than 1 mV to 3 V negative and is displayed on the panel meter.

The MP-1 is powered by a battery pack containing 5 NiCd "D" cells. A built-in trickle charger maintains the cells at full charge. A battery voltage check is provided on the front panel.

All components, except the battery pack and charger, are mounted on a single etched circuit board which is attached to the front panel. All integrated circuits and transistors are plugged into sockets for ease of maintenance.

B. SPECIFICATIONS

1. ELECTRONICS

a. Frequency: Switch-controlled base of 10, 20, 40, 80 or 160 cpm with multiplying factors of 1, 10, 100, 1k or 10k provides total span from 10 to 1.6 million cpm. Accurate to better than ±0.1% of switch setting. Manual pushbutton provides one pulse out for each actuation.

b. Amplitude: Switch-controlled COARSE settings of 3, 10, 30, 100 mV and 0.3, 1 and 3 volts full scale with FINE control. Accurate to within ±10% of meter reading, providing the load impedance is greater than 10k ohms.

c. Pulse Shape: Negative pulse; rise time 0.2 µseconds; width 2 µseconds fall time 3 µseconds.

d. Output: Capacitively coupled for direct connection to counter imput. Maximum DC voltage: 1500 V.

e. Output Impedance: Approximately 1k ohm.

f. Battery Life: Approximately 20 hours continuous with no recharge.

g. Recharge Time: Approximately 120 hours to fully recharge dead cells.

h. Temperature: 32°F to 140°F (0°C to 60°C) minimum range.

2. MECHANICAL

a. Size: 6 inches wide x 8-1/4 inches high x 8 inches deep (15.2 cm x 21 cm x 20.3 cm).

b. Weight: 6-1/2 pounds (3 kg).

3. POWER INPUT

115-230VAC, 1/8A, 50/60 Hz. Rear panel switch selects 115 or 230 VAC.

SECTION II
OPERATION

A. DESCRIPTION OF CONTROLS AND CONNECTORS

1. CPM: Three controls determine output pulse repetition rate in counts (pulses) per minute.

a. BASE: Rotary switch establishes base repetition rate.

b. MULT: Rotary switch establishes factor which is multiplied by the BASE number to determine output repetition rate.

c. MANUAL: Pushbutton for manual control of output repetition rate. The BASE control must be in this position and the MULT control has no effect. One pulse out for each actuation.

2. AMPLITUDE: Two controls plus meter readout of the amplitude of the output pulses.

a. COARSE: Rotary switch establishes the amplitude range of the output. Marked in volts for full scale meter reading.

b. FINE: Controls meter reading and output amplitude over the range selected by the COARSE control.

3. BATTERY CHECK: Pushbutton control that allows battery pack voltage to be presented on the meter. Indicates when battery voltage is outside prescribed limits.

4. POWER: Toggle switch which turns instrument on or off.

5. OUTPUT: BNC series coaxial connector.

NOTE

The output impedance is 1k ohm and the output amplitude is calibrated for a high load impedance. If the load impedance is comparable to 1k ohm, the loading effect must be accounted for.

6. POWER CORD: When plugged into an AC line the charger is charging the batteries. The power switch does not control this.

7. CALIBRATION CONTROL: This control is mounted internally on the etched board. It adjusts the meter indication to agree with the output pulse amplitude.

B. USING THE INSTRUMENT

1. CONNECTIONS: Connect a coaxial cable from the OUTPUT connector to the input of the instrument being tested. The shield should connect to ground and the center conductor to the input.

It is preferable to remove or turn down the high voltage in the instrument while testing; however, if this is impractical, the output of the MP-1 will withstand up to 1,500 volts.

2. TESTING INPUT SENSITIVITY: Set a frequency output which is conveniently read on the instrument. Vary the amplitude controls until the point is found where the instrument is marginally counting the input pulses. Smaller pulses will not be counted and larger ones will be reliably counted. This is the input sensitivity of the instrument. See NOTE under A, 5 above.

3. TESTING COUNT RATE CALIBRATION: The frequency output is the number set on the BASE control multiplied by the MULT factor. Turn the amplitude up slightly from that determined in 2 above for reliable counting.

The reading that should appear on the instrument depends on how that instrument is calibrated. If calibration is in cpm referred to true frequency, it should read the exact number set on the MP-1. If calibration is in cpm referred to emission from a radioactive source, it will read higher by the efficiency of its detector. If calibration is to some other units, such as mR/h, it will read differently by the sensitivity of its detector to those units.

The linearity of the instrument can easily be checked by varying the output frequency of the MP-1.

4. BATTERY CHECK: The batteries should be checked periodically by pressing the BATTERY CHECK button. The reading should fall within the marks on the meter.

SECTION III

THEORY OF OPERATION

The basic frequency is determined by a 26-2/3 kHz (1.6 million cpm) crystal oscillator. This frequency is applied to a string of 4 decade countdowns (A1 through A4), which divide their input frequencies by 10. Each of these frequencies is selectable by the MULT switch. The arm of this switch can therefore have frequencies of 1.6M, 160k, 16k, 1.6k or 160 cpm. This signal is applied to a string of 4 binary countdowns (A5 and A6) which divide their input frequencies by 2. Each of these frequencies is selectable by the BASE switch. The arm of this switch can therefore have frequencies of 160, 80, 40, 20 or 10 cpm, or higher by factors of 10 depending on the MULT switch position.

The signal from the BASE switch is applied to an emitter follower (Q5) which prevents excessive loading of the preceding circuitry. The output of Q5 is applied to an integrated circuit (A7) which is wired to function as a monostable multivibrator. This establishes the pulse width, which is preset at approximately 2 μseconds.

The output pulses from A7 are applied to Q2, which is normally off, and turn it on. This results in negative pulses at the collector of Q2. The fall time of the pulses is slowed by C5. The amplitude of the pulses is controlled by the DC voltage on the emitter of Q1, which is controlled by the setting of R12, the FINE AMPLITUDE control. The amplitude is read out by M1, which is calibrated by adjustment of R22.

The pulses are then applied to a precision resistor string on S6, the COARSE AMPLITUDE control. This attenuates the amplitude in a 3, 1, .3, .1, etc pattern from the applied.

From the switch arm, the pulses are applied to a cascaded emitter follower (Q3 and Q4), which has a very high input impedance to prevent loading of the attenuator. The output from the emitter follower is capacitively coupled to the OUTPUT connector. R17 and CR6 are for current limiting and voltage clipping which prevents damage to Q4 in case the output is shorted when C10 is charged to a high DC voltage.

The battery charger provides a continuous current into the batteries to maintain them at full charge. Resistor R20 is shorted when the instrument is on, which increases the charger current to compensate for the current drain of the instrument.

SECTION IV

MAINTENANCE

A. DISASSEMBLY

1. PANEL: The panel is removed by removing the 4 mounting screws. The etched board comes out with the panel. If it is desired to completely separate this from the cabinet, unsolder the three wires from the board. Be certain to note which wire goes to each lug.

2. ETCHED BOARD: To separate the etched board and and panel, remove the knobs and mounting nuts from the 3 rotary switches and the meter stud nuts. Unsolder the short jumper from the output connector. The board and panel can now be separated.

3. BATTERY PACK: Unplug the connector on the front surface of the pack. Remove the 2 binder head screws. The pack can now be pulled out. To remove cells from the pack, remove the cover plates and unsolder the jumpers between cells. When replacing cells be certain to observe polarity.

B. PREVENTIVE MAINTENANCE

No particular preventive maintenance is required other than keeping the instrument clean and dry.

C. CALIBRATION

The only calibration adjustment is to make the meter reading agree with the output amplitude. This should be done on the 100 mV scale. Adjust the FINE control for 60 mV output, as observed on an oscilloscope, then adjust R22 for a meter reading of 60 mV.

D. TROUBLESHOOTING

Most troubles can be isolated by tracing the signals through the instrument with an oscilloscope. Integrated circuits or transistors of the same type may be interchanged to aid in isolating troubles.

Preceding Q5 the signals are all "square" waves and the frequency is 26-2/3 kHz divided by whatever factor is switched in.

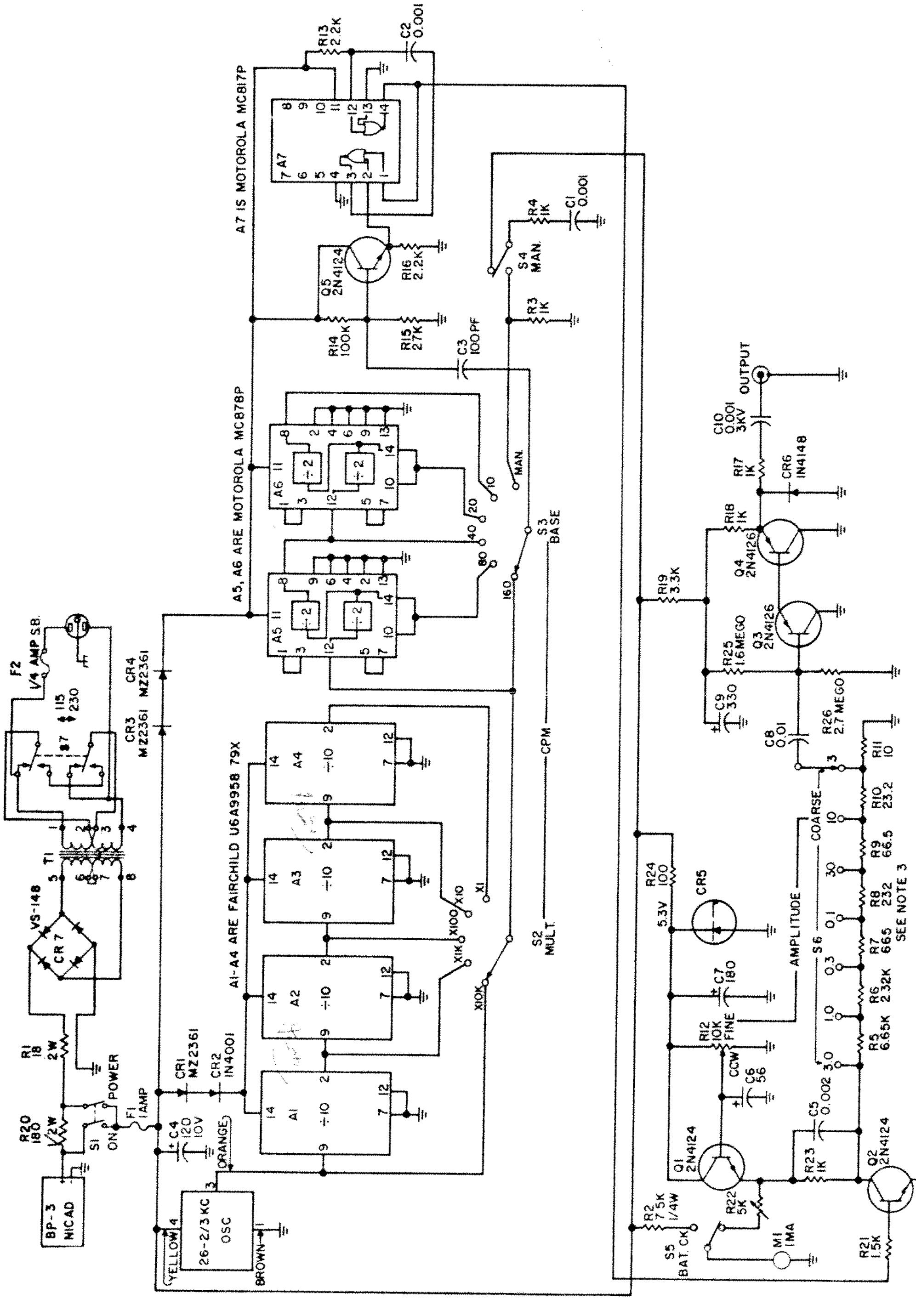
The pulse amplitude at the collector of Q2 should vary from 3 volts down depending on the FINE amplitude control setting. Output amplitudes should be attenuated from that on Q2's collector by the factor set on S6.

SECTION V
PARTS LIST

REF DESIG	PART	DESCRIPTION	MFR AND PART NO
		Osc, 26.666k Hz	Fork Standards #GO-6A-26.666-KC-BN-6 with Stud Mtg. and solder hooks
A1, A2, A3, A4	Integrated Circuit	Decade Counter	Fairchild U6A995879X
A5, A6	Integrated Circuit	Flip-Flop	Motorola MC878P
A7	Integrated Circuit	NOR Gate	Motorola MC817P
C1, C2	Capacitor	0.001 μF, 1kV Disc Ceramic	Centralab DD102
C3	Capacitor	100 pF, 1kV Disc Ceramic	Aerovox 1D1
C4	Capacitor	120 μF, 10V	Dickson D120C-10K1
C5	Capacitor	0.002 μF, 1kV Disc Ceramic	Centralab DD202
C6	Capacitor	56 μF, 6V	TI SCM-2
C7	Capacitor	180 μF, 6V	TI SCM-2
C8	Capacitor	0.01 μF, 100V	Aerovox P123ZG
C9	Capacitor	330 μF, 6V,	Kemet K33066
C10	Capacitor	0.001 μF, 3kV	Centralab DD30-102
CR1, CR3, CR4	Diode	MZ2361	Motorola
CR2	Diode	1N4001	
CR5	Diode	Zener, 5.3V	EIC 10416-A24
CR6	Diode	1N4148	
CR7	Diode	Bridge Rectifier	Varo VS148
F1	Fuse	1A, 3AG	
F2	Fuse	3AG, 1/4A, Slo-Blo	
Q1, Q2, Q5	Transistor	2N4124	
Q3, Q4	Transistor	2N4126	
R1	Resistor	18 Ω, 2W, 5%	
R2	Resistor	7.5k, 1/4W, 5%	
R3, R4, R17, R18, R23	Resistor	1k, 1/4W, 5%	
R5	Resistor	6650 Ω, 1/8W, 1%	IRC #CEA T-O
R6	Resistor	2320 Ω, 1/8W, 1%	IRC #CEA T-O
R7	Resistor	665 Ω, 1/8W, 1%	IRC #CEA T-O
R8	Resistor	232 Ω, 1/8W, 1%	IRC #CEA T-O
R9	Resistor	66.5 Ω, 1/8W, 1%	IRC #CEA T-O
R10	Resistor	23.2 Ω, 1/8W, 1%	IRC #CEA T-O

REF DESIG	PART	DESCRIPTION	MFR AND PART NO
R11	Resistor	10 Ω, 1/8W, 1%	IRC #CEA T-O
R12	Potentiometer	RV6 Style, 10k	CTS Series 300 or equiv. CTS 42444
R13, R16	Resistor	2.2k, 1/4W, 5%	
R14	Resistor	100k, 1/4W, 5%	
R15	Resistor	27k, 1/4W, 5%	
R19	Resistor	3.3k, 1/4W, 5%	
R20	Resistor	180 Ω, 1/2W, 5%	
R21	Resistor	1.5k, 1/4W, 5%	
R22	Potentiometer	5k, 1/4W	Mallory MTC53L1 or Bourns 3351W-5K
R24	Resistor	100 Ω, 1/4W, 5%	
R25	Resistor	1.6 M, 1/4W, 5%	
R26	Resistor	2.7 M, 1/4W, 5%	
T1	Transformer		Essex P6375

SECTION VI
DIAGRAMS



NOTES:
1. CAPACITOR VALUES IN MICROFARADS, RESISTOR VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. ALL RESISTORS 1/4W, 5% UNLESS OTHERWISE NOTED.
3. ALL RESISTORS IN S6, 1/8W, 1%.

Figure 6-1. General Schematic, Mini Pulser, Model MP-1

NO.	.N.	PER.	3522A 0014A	DESCRIPTION

This document is for Eberline in-house usage only and is subject to modification at any time. The process described herein is valid only if performed by Eberline personnel at Eberline facilities.

CHG.	APP.	DATE	DESCRIPTION	DATE	BY	CH'K
D1	ELB	9-22-82 2539	NO. OF PAGES FROM 4 TO 5. ADDED PERIOD AVERAGE METHOD, PG 3.	9/82		ELB
D	ELB	7-23-82 2472	Added shts. #3 + 4 Revised Title Block.	7/23/82	PM	Ref
C		4/12/76	BY WS +			

QA APP.	REV. D-1 9/23/82

EBERLINE INSTRUMENT CORPORATION
SANTA FE, NEW MEXICO

DR.		
CH'K.	ELB	4/12/76
PROJ. ENG.	WH	
APP.		

MINI PULSER

CHECKOUT PROCEDURE

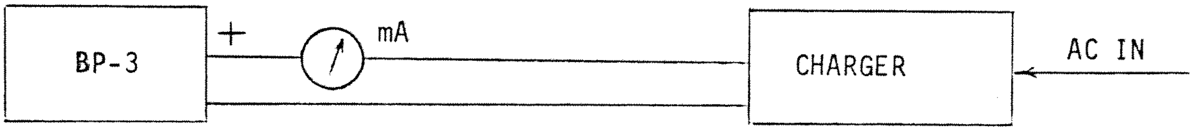
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRAC.	DEC.	ANG.
± 1/64	X.XX ± .015 X.XXX ± .005	± 1/2°

ALSO USED ON	EFF. WITH

SCALE

10429-A32 D Sheet 1 of 5

A. Hook Milliamp meter into circuit in series with battery (+) line only:



Use Fluke 8000A DVM on 2000 mA range for all current measurements.

1. With charger unplugged and power switch on, measure battery drain current. Should be 170 mA to 210 mA.

2. Plug charger into line. With power switch in both "ON" and "OFF" position, charging current must be 20 - 100 mA.

B. Remove milliammeter. Connect scope capable of measuring 2.0 millivolts to output connector and check pulse height as follows: Use a 3' straight coax cable.

1. With amplitude switch in 100 mV position, adjust fine control for 60 mV on scope. Adjust R22 for 60 mV indication on the meter.

2. Check linearity of 100 mV range every 10 mV from 30 mV to 100mV. Linearity to be ± 3 mV.

3. Check linearity btween scales at 2.5 mV, 6 mV, 25 mV, 250 mV, 0.6V and 2.5V. Readings to be ± 5 percent of full scale.

C. Connect a standard scaler to the MP-1 output connector.

1. Check MP-1 frequency using either the scaler method or the period average method as follows: (The period average method saves time.)

Scaler Method

MP-1 MULT	MP-1 BASE	SCALER READING (10 sec counts)
X1	160	26 ± 1
X10	160	266 ± 1
X100	160	2,666 ± 3
X1K	160	26,666 ± 27
X10K	160	266,666 ± 267
X1K	80	13,333 ± 14
X1K	40	6,666 ± 7
X1K	20	3,333 ± 4
X1K	10	1,666 ± 2

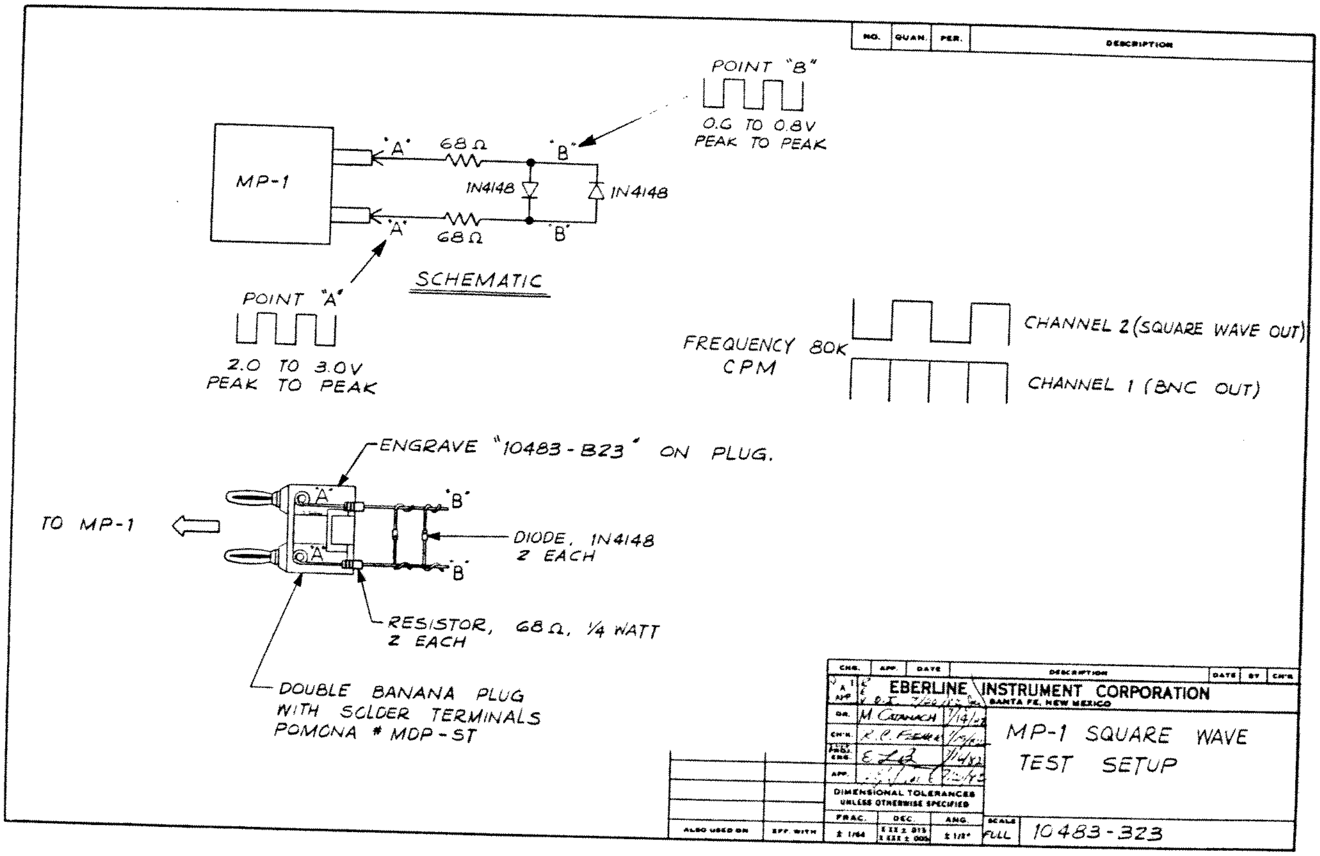
Period Average Method

MP-1 MULT	MP-1 BASE	PERIOD AVERAGE, MICROSECONDS
X1	160	374625 to 375375
X10	160	37462.5 to 37537.5
X100	160	3746.25 to 3753.75
X1K	160	374.625 to 375.375
X10K	160	37.4625 to 37.5375
X1K	80	749.25 to 750.75
X1K	40	1498.5 to 1501.5
X1K	20	2997 to 3003
X1K	10	5994 to 6006

2. Turn the scaler MP-1 to MANUAL. One count should register on scaler each time the MANUAL button is pushed.

D. For an MP-1 with square wave output (Twin Banana Jacks on front panel), proceed as follows:

1. Be sure MP-1 has passed all of steps in regular checkout procedure.
2. See Sheet 4 for a copy of print 10483-B23.
3. Either obtain or build the simple tester described on this print.
4. Plug tester (step No. 3) into banana jacks (Polarity means nothing) on MP-1.
5. Set frequency of MP-1 to 80K cpm.
6. Turn square wave "ON".
7. Set Amplitude Control to 300 mV.
8. Use a scope to look at square wave output at both point A's and B's. Output shall be a square wave with the following amplitudes (see 10483-B23):
    a. At point "A".........2.0 to 3.0 V, Peak-to-Peak.
    b. At point "B".........0.6 to 0.8 V, Peak-to-Peak.
9. Hook up the Scope as follows:
    a. Channel 1 of scope to regular MP-1 output (negative pulse) - (BNC Cable).
    b. Channel 2 of scope to point "B" of tester.
    c. Set scope to "ALTERNATE".
10. Observe Waveform Relationships as shown by 10483-B23. Polarity may be reversed, according to triggering, but there MUST be ONE complete cycle of square wave for every TWO negative pulses.


NO.
QUAN.
PER.
DESCRIPTION
POINT "B"
0.6 TO 0.8V
PEAK TO PEAK
MP-1
"A"
68 Ω
"B"
1N4148
1N4148
"A"
68 Ω
"B"
SCHEMATIC
POINT "A"
2.0 TO 3.0V
PEAK TO PEAK
FREQUENCY 80K
CPM
CHANNEL 2 (SQUARE WAVE OUT)
CHANNEL 1 (BNC OUT)
ENGRAVE "10483-B23" ON PLUG.
TO MP-1
"A"
"A"
"B"
"B"
DIODE, 1N4148
2 EACH
RESISTOR, 68 Ω, 1/4 WATT
2 EACH
DOUBLE BANANA PLUG
WITH SOLDER TERMINALS
POMONA # MDP-ST
CHG.
APP.
DATE
DESCRIPTION
DATE
BY
CH'K
EBERLINE INSTRUMENT CORPORATION
SANTA FE, NEW MEXICO
DR.
M. CAVANACH
7/14/82
CH'K.
R.P. FISHER
PROJ. ENG.
APP.
DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRAC.
± 1/64
DEC.
.XX ± .015
.XXX ± .005
ANG.
± 1/2°
SCALE
FULL
MP-1 SQUARE WAVE
TEST SETUP
10483-323
ALSO USED ON
EFF. WITH